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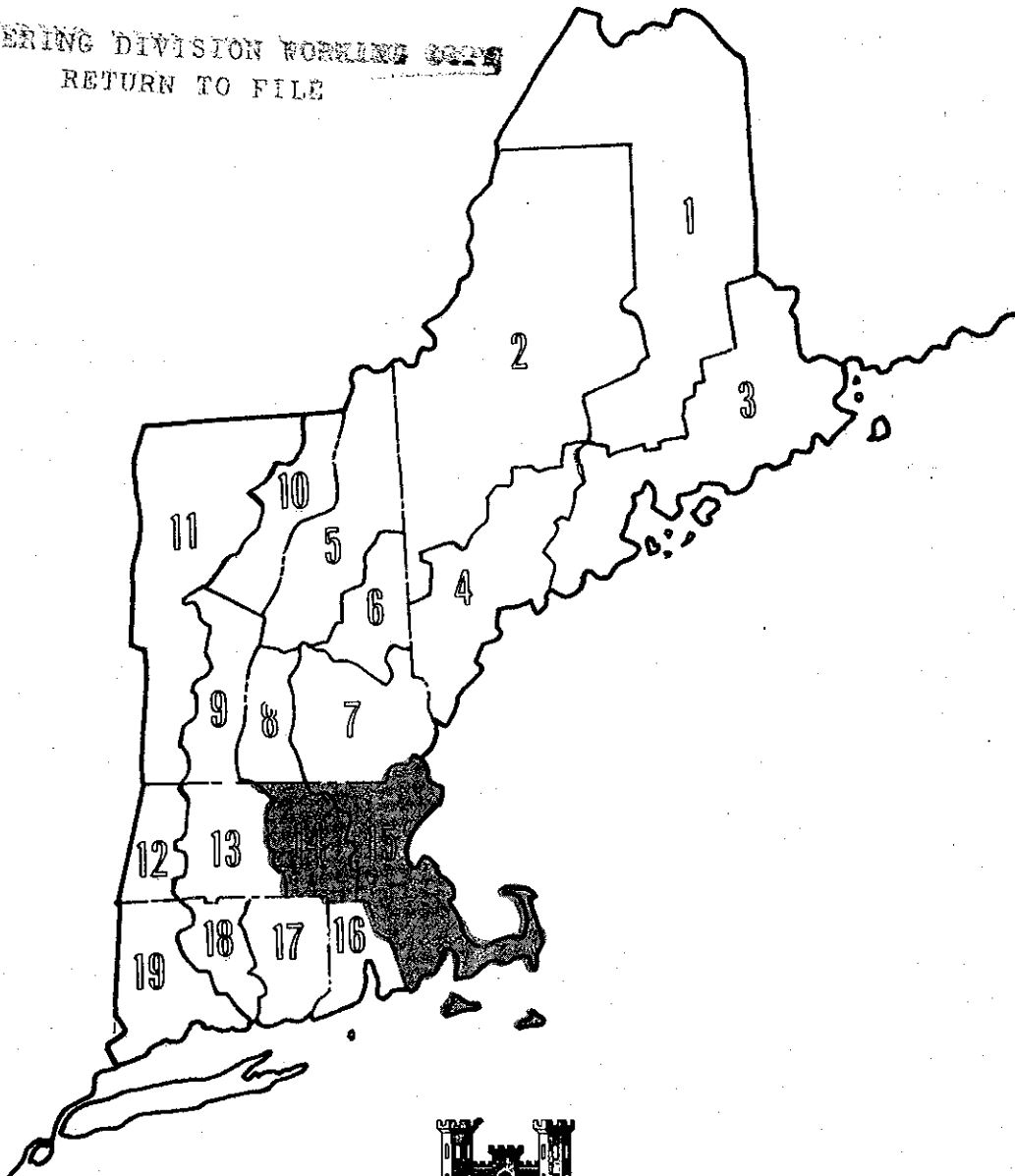
# NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

## WORCESTER-BOSTON

OBE SUB-REGION 14&15

### INTERIM MEMORANDUM NO. 5

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DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS.

SEPTEMBER 1968

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NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

INTERIM MEMO NO. 5

WORCESTER - BOSTON SUB-REGIONS  
(OBE Sub-Regions 14 & 15)

NEW ENGLAND DIVISION  
CORPS OF ENGINEERS, U. S. ARMY  
SEPTEMBER 1968

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## ABSTRACT

The Worcester - Boston Sub-Regions are investigated to determine future potential water supply requirements. The Metropolitan District Commission Water System, the major supplier in the sub-regions, with its present system coverage is studied in this memo. Projections of future populations and water supply needs are presented. The capability of the system to meet these needs is discussed. Recommendations for funds are requested under "NEWS" legislation (PL 89-298) to carry out further study of the sub-regions.

Worcester-Boston Sub-Regions  
OBE Sub-Regions Nos. 14 & 15  
Interim Memo No. 5

1. Purpose of Report

This Interim Memo is being submitted in accordance with scope of work detailed in memorandum dated 21 November 1967, as part of this Division's participation in the Northeast Water Supply Study for the New England Area.

2. Scope of Studies

a. General Information. Studies and investigations of reconnaissance scope have been made to determine the projected water supply requirements and potential deficiency areas within OBE Sub-Regions 14 and 15. The sub-regions are composed of 250 municipalities, 34 cities and 216 towns. Population is primarily located in 8 urban complexes. The largest of which is Boston Metropolitan area with a 1960 Population of 2,589,301 representing 59% of the sub-regions total 1960 population. Future populations are expected to cluster about these 8 urban complexes with urban population projected to be 94% of the 2020 estimated total of 10,749,000. A listing of counties in the sub-regions together with 1960 populations, and a location plan is shown on Plate No. 1.

The largest and most significant water system in the sub-regions is the Metropolitan District Commission Boston System. Since this system is the probable device which will be used to service the majority of the existing and future population in the area, it is upon this system that this report has focused its attention.

The broad regional coverage of the Metropolitan District Commission System (MDC) and its possible potential for servicing populations of municipalities other than those presently serviced suggested a three fold approach to the analysis of the system. This interim memo covers the existing Metropolitan District Commission system, or those municipalities as now serviced together with their projected water needs. Interim Memo No. 6 will note the future water requirements of those municipalities who under existing

Legislation have a right to connect to the system but have not as yet exercised this option. Interim Memo No. 7 will report those municipalities which may in the future petition to be admitted to the system. It is intended that the three memoranda 5, 6 and 7, be viewed as a total system output.

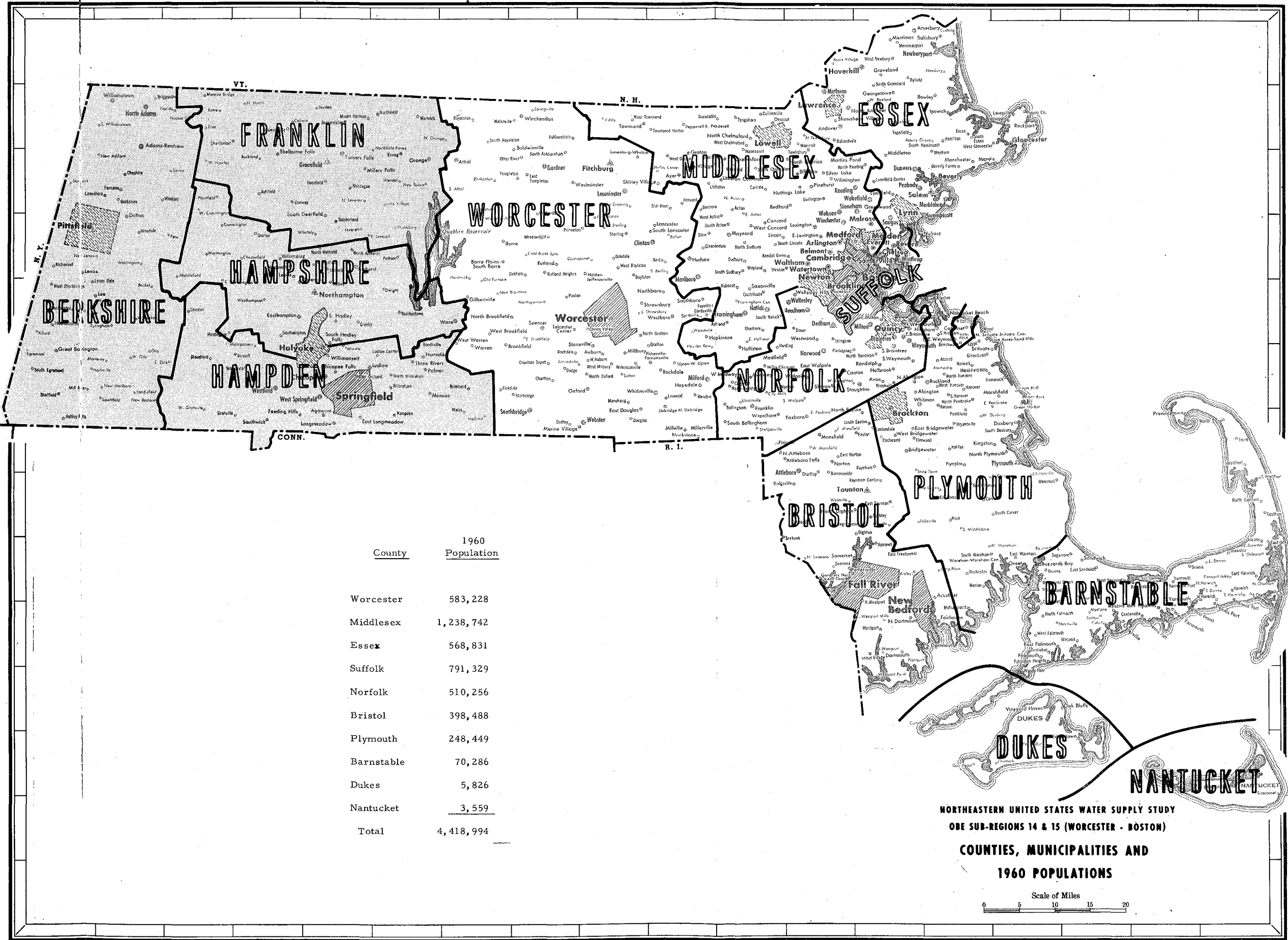
b. Office Studies. Office studies included collection and evaluation of data obtained; projections of water supply requirements and population for the individual systems and sub-regions and deficiency areas which may be developing were investigated. Proposals for plans and alternate solutions based upon preliminary hydrologic and cost estimates were developed and are contained later in this report.

c. Topographic Surveys. Topographic information was provided by U. S. Geological Survey maps scale 1:24,000.

d. Geologic and Subsurface Information. Sub-surface data was obtained from recent U. S. Geological Survey publications, consulting engineer reports and a report titled "Compilation of Geophysical Studies Conducted by Weston Geophysical Engineers, Inc. Throughout Massachusetts" prepared for the Massachusetts Water Resources Commission.

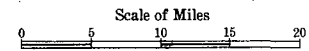
### 3. Prior Reports

Water Resources were considered in Part 2, Chapters XV, XVI, XVII, XX and XXI, "Merrimack River Basin, Massachusetts Coastal Area, Narragansett Bay Drainage Basins, Thames River Basin and Connecticut River Basin" of the Resources of the New England-New York Region. These comprehensive reports inventoried the resources of the New England-New York area and recommended a master plan to be used as a guide for the regional planning, development, conservation, and use of land, water and related resources of the region. Prepared by the New England-New York Inter-Agency Committee (NENYIAC), the report was submitted to the President of the United States by the Secretary of the Army on 27 April 1956. Part 1 and Chapter 1 of Part 2 are printed as Senate Document No. 14, 85th Congress, 1st Session.



County	1960 Population
Worcester	583,228
Middlesex	1,238,742
Essex	568,831
Suffolk	791,329
Norfolk	510,256
Bristol	398,488
Plymouth	248,449
Barnstable	70,286
Dukes	5,826
Nantucket	3,559
Total	4,418,994

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY  
ORE SUB-REGIONS 14 & 15 (WORCESTER - BOSTON)  
COUNTIES, MUNICIPALITIES AND  
1960 POPULATIONS



#### 4. Description of Sub-Regions 14 and 15

a. General. Sub-Regions 14 and 15 are located in the eastern half of Massachusetts. The area includes the ten counties of Worcester, Essex, Middlesex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Dukes and Nantucket. The western portion of the area occupies the eastern uplands of Massachusetts while the eastern portion is for the most part coastal plain. Climate is generally moderate with average monthly temperatures ranging from about 32 degrees F in January to about 72 degrees F in July. Monthly rainfall is well distributed throughout the year with the yearly average of about 46 inches being higher than the national average.

b. Surface Water. The metropolitan areas are principally drained by 4 major rivers, namely the Merrimack, Blackstone, Taunton and the Charles Rivers. The largest of the four is the Merrimack, (DA = 5, 010 sm) and the smallest is the Charles (DA -299 sm). The western portion of the sub-regions, largely rural, are drained by tributaries of the Connecticut River, the Chicopee and Millers with a combined DA of 642 sm in the sub-regions.

c. Ground Water and Existing wells. Ground water resources are found to a varying degree in all counties of the sub-regions. In 1965 a total of 147 separate water systems in the study area utilized this resource, with a reported developed yield of about 117 mgd, as their sole supply. In addition to these systems another 16 with a safe yield of 25 mgd used ground water resources to furnish more than one half of their requirements. The major system in the sub-regions, the MDC, however relies entirely upon surface water sources and supplied about 40% of the area's water supply requirements.

#### 5. Metropolitan District Commission Water Supply System

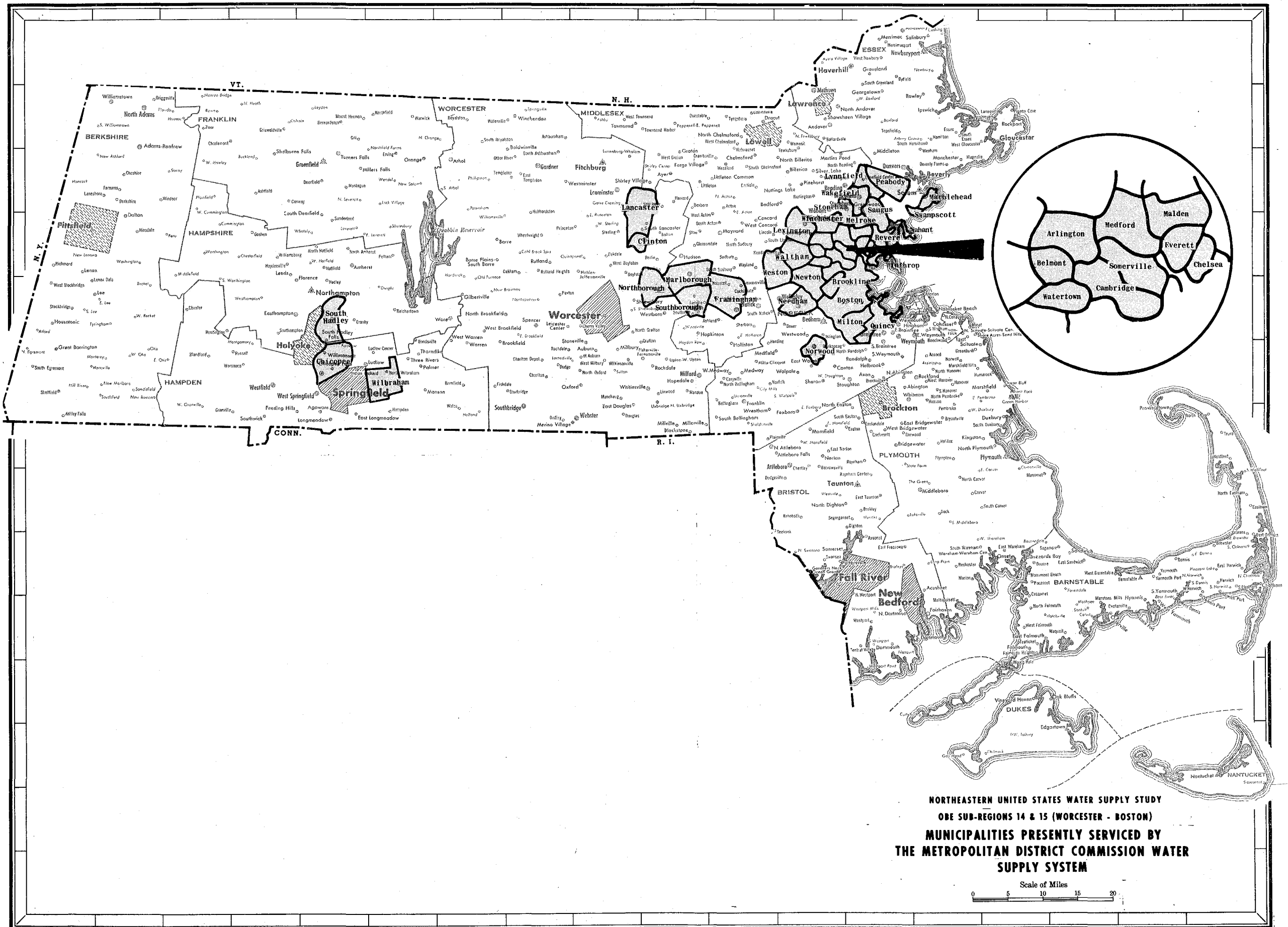
The Water District of the Metropolitan District includes 31 member municipalities with an estimated serviced population of about 1,800,000 in 1965. Of this number, 25 municipalities with an estimated population of 1,575,000 were served completely with water from Metropolitan District sources during 1965. The average daily consumption for these totally serviced communities in 1965 was about 227 mgd or 145 gallons per capita.

The cities and towns which currently comprise the Metropolitan Water District are as follows and are shown in Plate No. 2.

Arlington	Marblehead	Revere
Belmont	Medford	Saugus
Boston	Melrose	Somerville
Brookline	Milton	Stoneham
Cambridge (partial)	Nahant	Swampscott
Chelsea	Needham (partial)	Wakefield (partial)
Everett	Newton	Waltham
Lexington	Norwood	Watertown
Lynnfield Water Dis.	Peabody (partial)	Weston (partial)
Malden	Quincy	Winchester (partial)
		Winthrop

Other communities not a part of the Water District also allowed to draw from the system are as follows and are shown on Plate No. 2. The City of Chicopee, South Hadley Fire District No. 1 and the Town of Wilbraham obtain all of their water supplies and the Towns of Clinton, Lancaster, Northborough, Southborough and Framingham and the City of Marlborough and Leominster obtain a portion of their water supplies from the reservoirs and aqueducts of the Metropolitan District Commission. The City of Worcester maintains pumping facilities on the shore of the Wachusett Reservoir in West Boylston so that the City may purchase an emergency supply of water from the Commission when the city's water supply sources are inadequate to meet its demands.

The following description was provided by the Metropolitan District Commission and is used with their permission. A plan of the system is shown on Plate No. 3. Quabbin Reservoir was created in the Swift River Valley by erecting two large earth dams with concrete core walls, one known as the Winsor Dam and the other as the Goodnough Dike, formerly known as the Quabbin Dike. The Winsor Dam, named in Memory of Frank E. Winsor the late Chief Engineer of the former Metropolitan District Water Supply Commission, is 2,640 feet long, 170 feet high above the bed of the river and 295 feet above sound ledge foundation, and contains 4,000,000 cubic yards of earth fill above the original surface of the ground. A 400-foot spillway, with crest at elevation 530 feet above mean low tide, fixes the high water elevation of the Reservoir. The Goodnough Dike, situated approximately three miles east of Winsor Dam, is 2,140 feet long, 135 feet high above the bed of Old Beaver Brook and 264 feet above sound ledge foundation, and contains 2,500,000 cubic yards of earth fill.



The Quabbin Reservoir impounds the run-off from 186 square miles of the Swift River watershed and from 98 square miles of the Ware River watershed. It has a capacity of 412 billion gallons at full reservoir elevation. It is approximately 18 miles long with a water surface area of 38.6 square miles and a shore line of approximately 118 miles not including the shore line of some 60 islands. The maximum depth of water in front of the dam is 150 feet and the average depth eight miles above the dam is approximately 90 feet. It is believed that this is one of the largest, if not the largest, reservoirs in the world constructed solely for domestic water supply purposes.

As water from Quabbin Reservoir is required to supplement the supply in the Wachusett Reservoir, it flows through the Quabbin Aqueduct for a distance of 24.6 miles from the easterly shore of the Quabbin Reservoir to the Aqueduct outlet works; located at the upper end of Wachusett Reservoir in West Boylston.

This aqueduct, which is "horseshoe" shaped, with a cross section equivalent in area to a circle of 12 feet 9 inches in diameter, is excavated through solid rock and lined with concrete. Provisions have been made at the Ware River Intake Works at Coldbrook to divert the flood flows from approximately 98 square miles of the Ware River watershed into the aqueduct for storage in either the Quabbin Reservoir or the Wachusett Reservoir. Under ordinary circumstances, the water is diverted directly to the Quabbin Reservoir for storage and then is drawn back into the Wachusett Reservoir as occasion requires. Water may be diverted through the aqueduct from the Ware River to the Quabbin Reservoir at the rate of 930 million gallons per day and simultaneously to the Wachusett Reservoir at the rate of 970 million gallons per day. When the aqueduct is used for drawing water directly from Quabbin to the Wachusett Reservoir, it has a capacity of approximately 610 million gallons per day.

The Wachusett Reservoir on the Nashua River above Clinton was the principal reservoir of the Commission's water supply system prior to the construction of the Quabbin Reservoir. The reservoir was created by erecting a solid masonry dam known as the Wachusett Dam across the Nashua River. This Dam is approximately 205 feet in height above the average elevation of the

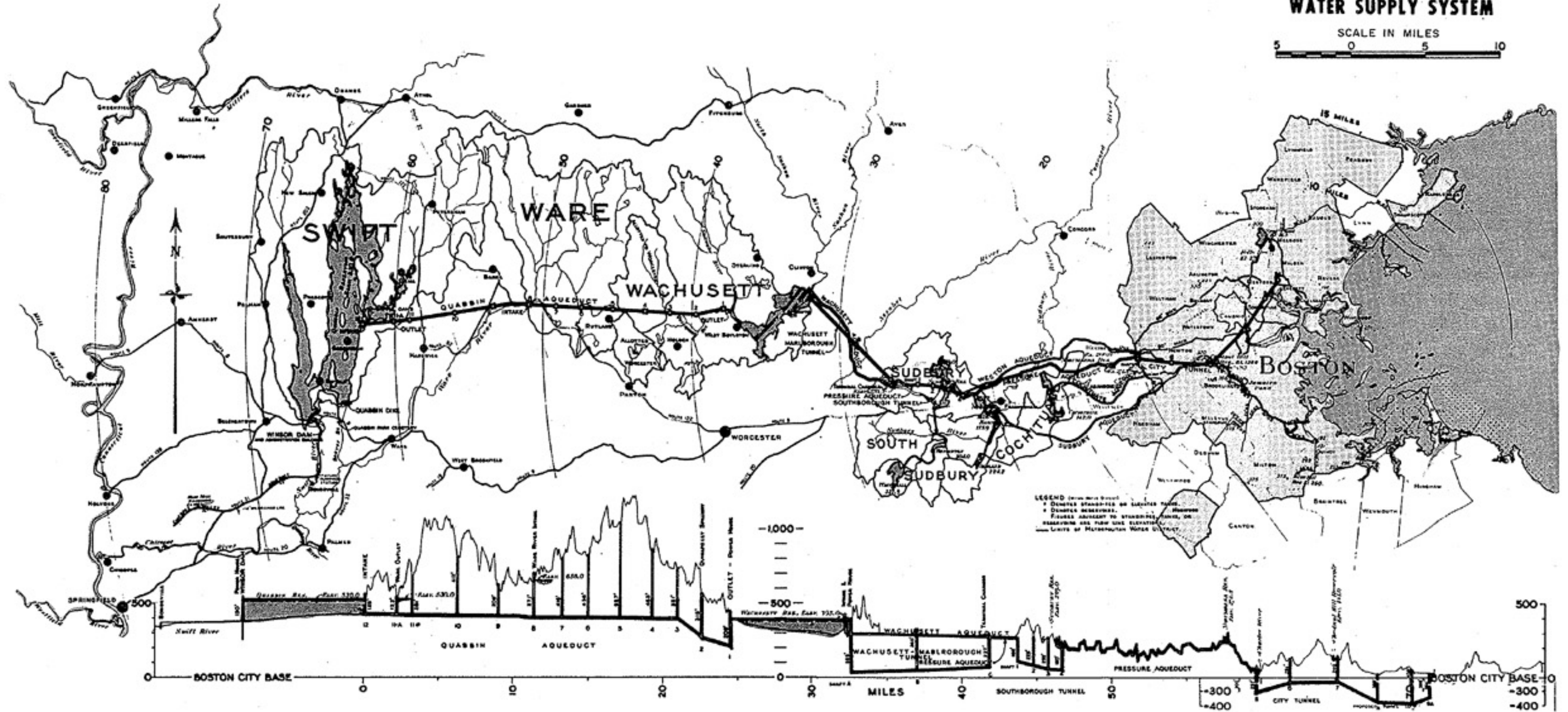
ledge foundation on which it is built, and rises about 115 feet above the height of the present surface of the ground. It is about 81 feet wide at the existing ground line and approximately 185 feet wide at its base. The main dam is 971 feet long with a waste weir 452 feet in length, extending beyond the main dam. This reservoir has a capacity of 65.0 billion gallons at elevation 395. It is approximately 8.4 miles long, with a water surface of 6.46 square miles, and has a shore line of 37 miles, not including islands. Its maximum depth in front of the dam is 129 feet and its average depth is 48 feet. The reservoir was first filled in 1908. At the present time, 107.69 square miles of the watershed of the south branch of the Nashua River are tributary to this reservoir.

Water now flows from the Wachusett Reservoir through the Wachusett Aqueduct into the intake of the Hultman Aqueduct in Marlborough and into the Sudbury Reservoir at Southborough. The Wachusett Aqueduct was first used in 1898. It has a capacity of approximately 300 million gallons per day. It consists of a rock tunnel section approximately 12 feet wide, 11 feet high and 2 miles in length, a brick and masonry conduit, "horseshoe" shaped, 11 feet 6 inches wide, 10 feet 6 inches high, 7 miles in length, and an open channel section 20 feet wide at the bottom and 3 miles in length.

The open channel section of the Wachusett Aqueduct terminates in the Sudbury Reservoir, the largest of seven reservoirs which were constructed by the City of Boston on the north and south branches of the Sudbury River between 1875 and 1898. This reservoir, situated on the north branch of the Sudbury River, was created by erecting an earth dam approximately 80 feet high with a concrete core wall across the river valley in the Fayville section of Southborough. It impounds the run-off from approximately 22 square miles of watershed and has a storage capacity of approximately 7 billion gallons at full reservoir elevation. It has a maximum depth of 65 feet and an average depth of 19 feet with a water surface area of 2 square miles. Prior to the completion of the construction of the Quabbin Reservoir, Quabbin Aqueduct and Hultman Aqueduct, this reservoir was one of the principal reservoirs in the water supply system and it is still used for water supply purposes. Although the Town of Southborough now obtains its water supply from the Commission's Hultman Aqueduct, it still maintains an emergency pumping

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY  
 OBE SUB-REGIONS 14 & 15 (WORCESTER - BOSTON)  
**PLAN OF THE METROPOLITAN DISTRICT COMMISSION  
 WATER SUPPLY SYSTEM**

SCALE IN MILES  
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station which can be used to pump water from this reservoir, and a portion of the water supplied to the Town of Framingham still comes from this reservoir. During the summer months, large quantities of water flow from this reservoir through the Sudbury Aqueduct to the Chestnut Hill Reservoir where it is pumped into the South High Service distribution system. The Sudbury Aqueduct is approximately  $17\frac{1}{2}$  miles long and has a capacity of 90 million gallons per day.

At the present time the major portion of the water supply is diverted from the Wachusett Aqueduct at a diversion dam on the open channel section of the aqueduct in Marlborough into the Hultman Aqueduct through which it is conveyed to the Norumbega Reservoir in Weston and through the City Tunnel to the distribution system. A portion of the water flowing in the Hultman Aqueduct is diverted to the Weston Aqueduct at a gate chamber located at the Sudbury Dam in Southborough. This water flows through the Weston Aqueduct to the Weston Reservoir; thence to the Boston Low Service distribution system. This Aqueduct is approximately  $13\frac{1}{2}$  miles long, has a capacity of 300 million gallons per day and was first used in 1903.

The remaining portion of the water flowing in the Wachusett Aqueduct is allowed to by-pass the intake chamber on the Hultman Aqueduct at Marlborough and continues to flow through the open channel section of the Wachusett Aqueduct into the Sudbury Reservoir so that a sufficient quantity of water may be maintained in this reservoir to meet peak demands during summer months and for emergency purposes throughout the year.

A new aqueduct of deep rock cement-lined tunnel, 14 feet in diameter and 8.0 miles long, known as the Wachusett-Marlborough Tunnel, extending from the Wachusett Reservoir at Clinton to the Hultman aqueduct intake structure at Marlborough, has recently been constructed. When the intake structure of this aqueduct, which is now in the final construction phase on the shore of the Wachusett Reservoir, is completed and this aqueduct placed in complete service, the entire water supply requirements of the Metropolitan

Water District will be delivered through the new aqueduct to the Hultman Aqueduct at Marlborough, thence through this aqueduct to the Norumbega and Weston distribution reservoirs, the City Tunnel, and large distribution mains. The use of the new tunnel will enable the Commission to operate the Hultman Aqueduct under pressure and increase its present carrying capacity of 250 million gallons a day to 375 million gallons a day. In the event the Commission desires at some time in the future to construct a second aqueduct, parallel to the existing Hultman Aqueduct, the new tunnel would provide a means of conveying quantities of water up to 500 million gallons a day from Wachusett Reservoir to the Commission's distribution system.

The Hultman Aqueduct begins at the diversion dam mentioned above and extends for a distance of approximately 22.7 miles in an easterly direction to the Chestnut Hill Reservoir and Pumping Stations. The first section, approximately 1.8 miles in length, consists of a precast, reinforced-concrete conduit 12.5 feet in diameter, of cut-and-cover construction. The second section is a 14-foot tunnel, approximately 3 miles long, beneath the Sudbury Reservoir. This tunnel terminates at a gate chamber at shaft 4 at the Sudbury Dam. The next section is another precast, reinforced conduit, 11 feet 6 inches in diameter, of cut-and-cover construction, extending to a downtake shaft at the Charles River in Weston. The City of Marlborough and the Towns of Southborough and Framingham pump their water supply requirements from this aqueduct, and the Town of Weston, which joined the Metropolitan Water District in 1963, began pumping a portion of its water supply requirements from this aqueduct in 1965.

The first portion of the City Tunnel, consisting of a concrete-lined, deep rock tunnel 12 feet in diameter, extends from the shaft at the Charles River, a distance of approximately 5 miles to a point in the vicinity of the Chestnut Hill Reservoir in Boston, where it is connected directly to several large distribution mains which convey the water to several of the communities serviced by the Low Service, Southern High and Southern Extra High distribution systems. The City Tunnel, reduced from 12 feet to 10 feet in diameter, extends from the Chestnut Hill

Reservoir, a distance of approximately 7 miles, to a point in Malden, where it is connected directly into large distribution mains which convey the water to other communities serviced by the Low Service, Northern High and Northern Extra High Service distribution systems.

Since the City Tunnel system has been connected to existing distribution mains in Malden and Medford, an ample supply of water has been made available to the communities which obtain their water supply from the Northern distribution systems. The amount of water which the Commission has been required to pump at its Chestnut Hill Pumping Stations in Boston and at its Spot Pond Pumping Station in Stoneham, in order to maintain adequate pressures in the distribution system, has been materially reduced. However, it will be necessary to maintain these pumping stations and the Sudbury Aqueduct in first-class operating condition at all times, so that, should it become necessary to interrupt the flow of water through the Hultman Aqueduct and City Tunnel, these facilities may immediately be placed in service. The Commission plans to construct an additional deep rock tunnel, extending from Chestnut Hill Reservoir in Boston to a point in the vicinity of the Boston-Milton town line at Dorchester Lower Mills. The new tunnel will enable the Commission to improve pressures in its Southern High and Southern Extra High Service distribution systems. This project is scheduled to be let out for bids in September, 1968 with construction estimated to take about 4 years.

Water from the Commission's reservoir and aqueduct system flows by gravity or is pumped through the Commission's distribution system to the water mains of the thirty-one member municipalities. At the present time there are approximately 250 miles of distribution mains in the system, 96% of which range from sizes 16" to 60" in diameter. There are 14 distribution reservoirs in the system with capacities varying between 2.0 and 1,838 million gallons. In order to maintain sufficient pressures throughout the distribution system, it is necessary at the present time to maintain and periodically operate 12 pumping stations. The total pumping capacity of the various units in these stations is approximately 450 million gallons per day.

The Chicopee Valley Aqueduct, which conveys water from Quabbin Reservoir to the Town of Wilbraham, South Hadley

Fire District No. 1 and the City of Chicopee, extends from the outlet works of Winsor Dam to the Keating Hill Standpipe of the City of Chicopee. The Commission built the portion of this aqueduct which extends from the Winsor Dam to the Chicopee city line. It consists of about 24,000 feet of 48-inch reinforced-concrete steel-cylinder pressure pipe, extending southerly from the outlet works through the Towns of Belchertown and Ware to a point where the aqueduct crosses the Swift River. From this point the 45,000 feet of 36-inch pipe, extends in a westerly direction through the Towns of Belchertown and Ludlow to the Commission's Nash Hill Reservoir in Ludlow. The Nash Hill Reservoir has a capacity of approximately 25 million gallons. From this reservoir, the aqueduct, consisting of approximately 9,000 feet of similar 36-inch pipe, extends in a westerly direction through Ludlow to the Chicopee city line. At this point the Commission's aqueduct is connected to a 36-inch cast-iron water main approximately 3 miles in length, which conveys the water to the City's Keating Hill Standpipe. This aqueduct is capable of delivering approximately 23 million gallons per day from Quabbin Reservoir to the Nash Hill Reservoir.

#### 6. Projected Future Water Requirements

Population projections and future water requirements presented in this report are of a preliminary nature. They do not include any possible major shift of heavy water using industry over that presently serviced to the area. The projections and future water demands are, however, intended to provide a comparison between available resources and reasonably anticipated future requirements affording an outline of potential deficiency areas.

The population projections (1) and water supply requirements for the municipalities presently serviced by the Metropolitan District Commission are as follows:

POPULATION PROJECTIONS AND FUTURE WATER  
SUPPLY REQUIREMENTS

1. Municipalities Completely Serviced

<u>Municipality</u>	<u>1975</u>		<u>1990</u>	
	<u>Population<sup>(1)</sup></u>	<u>MGD<sup>(2)</sup></u>	<u>Population</u>	<u>MGD</u>
Arlington	55,000	6.0	56,300	7.3
Belmont	30,200	2.6	33,400	3.8
Boston	606,300	134.5	626,900	178.9
Brookline	50,300	6.7	56,900	9.4
Chelsea	20,100	3.2	24,800	4.9
Everett	40,800	7.8	57,700	10.6
Lexington	35,400	4.8	38,400	9.0
Lynnfield	5,400	.4	7,800	.7
(water district)				
Malden	51,300	5.6	49,800	8.3
Marblehead	25,000	2.5	30,300	3.7
Medford	58,300	7.0	66,700	9.5
Melrose	34,200	3.1	34,300	4.3
Milton	28,100	2.6	37,100	4.3
Nahant	5,300	.5	8,000	.9
Newton	93,400	12.4	104,200	16.0
Norwood	35,500	4.7	38,400	6.5
Quincy	90,600	10.4	97,800	13.5
Revere	43,200	4.2	47,300	5.4
Saugus	25,000	2.2	26,500	3.2
Somerville	79,600	9.6	83,700	12.1
Stoneham	23,900	3.0	26,700	3.9
Swampscott	16,500	1.2	19,600	1.5
Waltham	58,400	9.7	60,500	12.1
Watertown	39,200	5.3	40,600	6.3
Winthrop	23,800	2.4	23,500	3.5
Sub-total	1,574,800	252.4	1,697,200	335.5

(1) Based on projections developed by the Metropolitan Area Planning Council, Regional Planning Commission.

(2) Projections developed by Camp, Dresser and McKee, Engineers for Metropolitan Area Planning Council, Massachusetts, Department of Commerce and Development, Massachusetts Bay Transportation Authority and the Massachusetts Department of Public Works.

## 2. Municipalities Partially Serviced<sup>(1)</sup>

<u>Municipality</u>	<u>1975</u>		<u>1990</u>	
	<u>Population</u>	<u>MGD</u>	<u>Population</u>	<u>MGD</u>
Cambridge	94,200	10.6	99,100	13.9
Clinton	12,800	2.2	17,400	3.4
Framingham	69,600	8.2	72,800	12.5
Lancaster	5,600	-	9,700	-
Leominster	35,000	4.0	42,000	7.0
Marlboro	27,200	1.1	38,300	3.6
Needham	33,100	.5	36,300	3.4
Northborough	13,000	-	29,200	1.2
Peabody	49,300	2.0	63,200	10.4
Southborough	6,000	.5	11,300	1.2
Wakefield	28,100	1.7	31,900	3.0
Weston	12,800	-	28,500	.4
Winchester	<u>21,400</u>	<u>2.2</u>	<u>23,000</u>	<u>3.7</u>
Sub-total	408,100	33.0	502,700	63.7

## 3. Chicopee Valley Aqueduct

Chicopee	80,000	14.0	88,000	16.0
Wilbraham	12,500	.8	16,300	1.2
So. Hadley Fire				
Dist. No. 1	<u>13,700</u>	<u>2.0</u>	<u>18,800</u>	<u>3.0</u>
Sub-total	106,200	16.8	123,100	20.2
TOTALS	2,089,100	302.2	2,323,000	419.4

## 7. Water System's Capability of Meet Projected Demands

The estimated safe yield of the Quabbin Reservoir, the Ware River and the Wachusett Reservoir all of which presently supply the MDC system is about 335 million gallons per day. The

(1) Figures shown for water requirements are based on the assumption that these municipalities will continue to meet their future demands, which are in excess of their presently developed sources, from the MDC system.

Commission is presently planning to divert waters directly from the Connecticut River during the spring freshets via a proposed pumped storage hydroelectric site on Northfield Mountain. This diversion would consist of pumping water from the Connecticut River when flows are in excess of 15,000 cfs (estimate to occur about 70-80 days per year during spring freshet periods). These flows are then stored at the new reservoir on Northfield Mountain and water will flow from this reservoir by means of a new 10-foot diameter, ten-mile long aqueduct to Quabbin Reservoir. The water is then conveyed from Quabbin through existing aqueducts to the Metropolitan Boston area.

The additional yield to Quabbin available by way of the Northfield Mountain project is estimated to be about 72 mgd. This additional source would increase the system's total safe yield from 335 mgd to 407 mgd. The projected 1990 water supply requirement is about 416 mgd. On this basis, the addition of the Northfield Mountain project could allow the MDC to meet its requirements, to about 1990, but only if it were to limit its service to its present system coverage of 28 municipalities now fully supplied and 13 municipalities on a partial basis.

#### 8. Conclusions

The Metropolitan District Commission could upon completion of the planned Northfield Mountain Power Project have, by reason of the proposed diversion, an estimated safe yield of about 400 mgd. It is believed that the metropolitan regional coverage of the MDC qualifies the system for assistance under the "NEWS" legislation (P. L. 89-298). Study of alternate sources for the system, such as the Millers River (Tully Dam), the Deerfield River and others would be required to determine whether consideration should be given to Federal cost-sharing of the proposed Northfield Mountain project. The water supply diversion portion of this Northfield Mountain project is estimated to cost some 25 millions.

Expected population growth and increased per-capita consumption of the presently serviced municipalities will cause the MDC system, even with the Northfield Mountain diversion to be inadequate from a source viewpoint about 1990. Since present population estimates indicate a possible 61% increase in the sub-regions by 2020, it appears development of other major supply sources will be required if the MDC system is to meet its demands beyond 1990.

Although this report studies only the ability of the MDC to meet water supply requirements for the presently serviced municipalities it is recognized that other communities may soon have to be serviced by the MDC. The effect of these additional municipalities connecting to the system is evaluated and reported in Interim Memos Nos. 6 and 7.

#### 9. Recommendations

In order to ensure an adequate and dependable future water supply for those municipalities presently serviced by the MDC the following course of action is recommended:

Feasibility study of the Worcester-Boston Sub-Regions to determine in detail future populations and their water supply requirements. This study would investigate new sources to meet future demands, formulate plans and alternates and recommend a plan of resource development for future water supply requirements of the sub-regions. Costs for a feasibility study of this scope are estimated to be \$300,000 and is further discussed in Memos No. 6 and No. 7.